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Sophomore Honors English A3

17 March 2015

Of Moons and Men: The Decline and Fall of the Soviet Lunar Program

**10 February 1969:**

It was close to five thirty in the morning when the telephone rang.

“Fyodor Ilarivich Kuznetsov here,” I said groggily into the mouthpiece, just moments after departing from the peaceful oblivion of sleep.

“Hello, Fyodor Ilarivich,” came a voice from the other end of the line. I recognized it as that of Vasily Mishin, my boss.

“Chief Designer! What brings you to call me at this hour?” I said.

“We held a meeting yesterday in Tyuratam about the upcoming test flight of the 3L vehicle, and it was decided that we will move the date of the first launch up to the 21st of February. The rocket's already on the pad. I need you to drop your design work at the bureau and come down here to the Cosmodrome to oversee the final preparations.”

“Got it, Vasily Pavlovich. I’ll be out there shortly.”

“I wish you a pleasant journey. Goodbye.”

I put the phone down and grudgingly got off of the couch. My wife, Kathya, was asleep in bed in the adjoining room, and I made no attempt to wake her; I figured that it would be easier for her, and me, if I just slipped off into the early morning and left a note behind as I had done on a multitude of previous departures. To prepare for my trip, I took out my briefcase and meticulously packed my personal effects into it, including my toothbrush, spare clothes, and a set of technical drawings that I had drafted. There was no need for me to get dressed, since I was still wearing my work attire from the night before.

I walked across my small flat to the kitchen, where I set my briefcase down on the dining table near the window and started to fix myself a light breakfast of bread, butter, and a glass of milk. Regrettably, my stores of coffee had run out some time before.

“Good morning,” Kathya said, standing in the doorway of the kitchen.

“Morning,” I replied.

“How late were you up last night? I didn’t see you go to bed.”

“I think I finished up with work around two or three.”

“Fyodor, you know that’s not healthy,” Kathya said, with a tone of reproof in her voice, before adding, “You still can’t tell me what you’re working on, can you?”

I shook my head. “State security. My superiors want it kept a secret.”

My work was fascinating, and I would have loved to describe it to her, but no man in his right mind would dare risk the wrath of the Soviet bureaucracy with such a breach of secrecy.

“I presume you also can’t tell me where you’re going, or how long you’ll be there,” Kathya pointed at the briefcase.

“State security again. Now, if you’ll excuse me, I have a train to catch soon.”

I put my breakfast plate away, put on my overcoat, and bade a brief, melancholy farewell to my wife before heading out the door. Two flights of stairs lay between me and the apartment building’s ground floor, and after I had traversed both of them I entered Russia’s frigid winter air and headed for my 1960 Volga car parked in the road nearby. The engine had some trouble starting.

My first stop in the city of Podlipki was the headquarters of the OKB-1 design bureau, where I picked up some additional papers from my office, and after that was accomplished I drove to a train station in Moscow where I embarked on the first train out to Kazakhstan. The journey was long, but it afforded me time to cram in some extra work.

Upon my arrival at Baikonur, I was directed by Deputy Chief Designer Boris Dorofeev to meet Mishin at the Site 110 launchpad. I proceeded eagerly, less because I wanted to meet with the Chief Designer and more due to my desire to see a real-life version of the vessel that I had worked on for more than four years.

Suffice to say, it did not disappoint. The conical grey and white rocket towered more than 105 meters into the sky, standing boldly over the bleak expanse of the surrounding steppe as a colossal monument to the Soviet Union’s technical prowess, and I half-expected the concrete launchpad to sag under its nearly three thousand tons of metal structure and volatile propellants. It had to be that massive to reach the Moon. The plan was for the three-stage N-1 to boost into orbit a complex known as the L3, which comprised two rocket stages, the Block-G and Block-D, along with a two-man, Soyuz-derived LOK spacecraft and a one-man lunar lander known as the LK. This particular launch was just a test flight carrying a stripped-down LOK vessel without crew. Assuming that it was successful, the OKB-1 team figured that only a few more experimental launches would be needed before we could start sending cosmonauts to plant the hammer and sickle on the Moon; if we pulled such a daunting endeavor off, we would have once and for all proved the superiority of the people of the Soviet Union over the American capitalists.

Scores of technicians scurried frenetically around me as they made sure that every minute component was in working order for the upcoming test flight. Standing near them was Mishin, who periodically shouted orders and collected reports from his underlings.

“Comrade Fyodor Ilarivich! It’s good to see you out here at Baikonur,” he greeted, offering a handshake that I somewhat awkwardly accepted.

“Good to see you, too. How have the systems checks been going?” I replied.

“Well enough. Unit 3L came off the factory floor with few manufacturing errors, but I’m afraid that the strain of transporting it here has caused a number of issues. The KORD flight control system seems to be a little cantankerous, as well; Boris Chertok wants you to review it with him at some point. But, aside from those minor nuisances, the rocket’s fine.”

I glanced over to N1-3L, sending a mental warning that it had better stay that way.

“That’s good to hear. It’s a great time for the Motherland, isn’t it?”

“Truly. In just eleven days, we’ll see our ship ascend towards the skies for the first time.”

“It’s a shame that Korolev won’t be here to see it.”

Mishin nodded, and we both spared a moment of silence for the deceased architect of the Soviet space program. Sergei Korolev was one of those immensely talented and determined great men who are born just once every decade or two; the R-7 missile, Sputnik, Vostok, and the other grand successes of the ongoing space race against the Americans were all primarily of his devising, and he had laid out the foundation for the N-1. When I was an engineering student right in the middle of college, Korolev found me promising and took me under his wing. I owed my position as the lead designer for the N-1’s Block-A first stage to him.

I remember that he often spoke of how expansion into space was the next bold step in the progress of mankind. Korolev had a dream of conquering the Moon, then moving on to the other planets to spread the light of civilization amongst the empty stars, and the more I listened to him the more I started to share that dream. When Korolev died in 1966 from overwork-aggravated surgical complications, I resolved to finish the work that he started.

**21 February 1969:**

The fire control bunker was hot and crowded, with a plethora of individuals ranging from engineers such as myself to Party functionaries crammed inside to watch the launch. A countdown clock mounted on the far side of the room marched glacially towards liftoff while I elbowed my way to a decent view near one of the small windows. I ended up bumping into my superiors Mishin and Dorofeev, who promptly introduced me to several unfamiliar faces, such as Commander of the Sixth Directorate Yevegney Moisseyev and Minister Sergei Afanasiev; I anxiously shook hands with them and attempted to put on the veneer of civility that was expected in the presence of individuals with such august, if vague, titles.

At last, when my wristwatch read 12:17 Moscow Time, Moisseyev slammed his hand down on the launch button to initiate liftoff. I could see the thirty NK-15 engines of the N-1 Block-A start to spew flame onto the pad almost immediately. As my design team and I had anticipated, even the mammoth Block-A took a full twelve seconds to push the rocket off of the ground, and once airborne the spacecraft remained sluggish for a while as it lifted its ponderous weight up into the sky atop a column of fire. I joined several other engineers in cheering loudly for our collective brainchild, to the surprise of a few of the gathered officials.

Everything seemed fine, at first: after craning my neck in a rather uncomfortable fashion, I could track the rapidly receding conical figure of the N-1 as it continued onwards on its anticipated flight path. It let out a deafening roar as torrents of kerosene and liquid oxygen combusted violently in its engine chambers.

At T+55 seconds, that reaction stopped as suddenly as if an invisible hand had reached in and cupped the back of the rocket; the trail of exhaust instantly dissipated into tenuous wisps of smoke while the N-1 briefly continued upwards on a ballistic trajectory. There was a burst of flame at its tip as the launch escape system motor delivered the unmanned L1 capsule to safety.

My breathing stopped at almost the same time the engines did.

“We just lost all of the Block-A motors!” one of the telemetry officers shouted.

“I’m also reading that the launch escape rocket activated,” another said.

“Can you confirm?” Mishin said.

“Yes, Chief Designer, I can confirm,” I replied, my eyes fixated in horror on the sky.

The N-1 started to plummet, though it was but a glimmer in the distance that I could barely track, and I heard mention of an onboard fire from someone nearby. Finally, when the mission elapsed time was at just under two minutes, it impacted the Baikonur steppe several kilometers away with nothing but a brief but luminous flash of light.

For several seconds, not a word was spoken. One of the men poring over the N-1 flight data was the first to break the silence.

“I just analyzed the flight log… It looks like engines 12 and 24 shut down shortly after launch, followed by the rest of the NK-15 units at T+ 68.7 seconds,” he said.

“Have you any indication as to what caused the shutdowns?” I asked.

“None at all, Comrade Lead Designer.”

“Could it have been a failure in the fuel pipelines?” Dorofeev speculated.

“Or maybe the KORD system was responsible: after all, it can shut down engines in the event of an emergency,” I stated.

“I know what caused it!” Mishin exclaimed, “The failure was in Andronnik Iosifyan’s power system! He installed faulty turbo-generators in the rocket, and when they ceased to provide electricity the engines had to shut down.”

“How can you come to a conclusion like that so quickly, Vasily Pavlovich? A catastrophe like this will most likely require weeks of analysis before we can determine conclusively what the cause was,” I replied, eager to defend both my beloved Block-A first stage and one of the best engineers under my command.

“What, aside from a power failure, could have made the engines cut out simultaneously?”

“I don’t know, but all I’m saying is that we need to conduct a more extensive investigation before we can place blame anywhere.”

“I’m inclined to agree with Fyodor on this one. We need to figure out exactly what happened with this launch, then fix the issue before we send up 5L later this year. Keep in mind, though, that we have very little time left,” Dorofeev said.

**7 March 1969:**

My design team spent the next several days poring over the telemetry regarding the operation of the first stage, along with the profusion of mangled wreckage that was recovered from the plains around Baikonur, and while we discovered numerous hitherto unknown design flaws we could not quite ascertain the cause of N1-3L’s catastrophic failure. We did, however, determine that there was a small fire in the aft end of the first stage, but this would not have been nearly enough to simultaneously deactivate twenty-eight engines.

The only area in which we made any progress was determining what did not transpire during the launch; Iosifyan was exonerated of Mishin’s accusation against him when we recovered what was left of the power generators from the steppe and determined that they had been in operating condition right up until the crash.

Boris Chertok led his own investigative committee to examine the KORD control system that he had developed for the first stage. Though that investigation technically fell under my purview, I was far too busy with other pressing matters to oversee it and as such I was just as intrigued as anyone when Chertok presented his findings to a meeting of engineers on March 7.

“Gentlemen, I spent the last two weeks painstakingly analyzing every piece of telemetry from the 3L test flight, and I have arrived at the regrettable conclusion that it was the KORD system that caused the engine shutdown and the ensuing crash of the rocket,” he addressed the other occupants of the conference room. The table in front of him held a small mountain of haphazardly arranged technical reports and printouts of computer code.

“How, exactly, did this happen?” Mishin asked.

“Well, as Kuznetsov has determined,” Chertok briefly gestured towards me, “there was a fire in the aft section of the Block-A about 55 seconds after liftoff, caused by a combination of extreme heat and vibrations. While the conflagration was not large enough to directly impede the engines, it caused a short circuit in the KORD that made it erroneously detect a number of malfunctions, and consequently the control system used its emergency shutdown protocols to deactivate every engine on the first stage.”

“Well, that seems to have solved the mystery of what caused the launch failure. How do we keep this from happening on the next test flight?” Mishin said.

“I don’t know, Chief Designer.”

“I suggest that you start working on it,” Mishin commanded. He took a look at the clock on the opposite wall, then said, “Well, would you look at the time? It seems like the hours have certainly slipped by on us, so I shall adjourn this meeting until tomorrow. You’re all dismissed.”

I started to head for the door, but the Chief Designer stopped me before I could exit.

“Comrade Fyodor Ilarivich, I’d like a word with you,” he said.

“Sure. What is it that you wish to discuss?” I replied.

“Have you heard of the latest technical achievements of the Americans, by any chance?”

“Only what was written in *Pravda*, which is not much. I’m aware that they sent a manned mission to orbit the Moon last year.”

“Yes, yes. What they probably didn’t tell you was that the most recent expedition, Apollo 9, the Americans call it, was launched atop their counterpart to the N-1 and carried full-scale versions of their lander and lunar orbiter to Earth’s orbit.”

I frowned. I knew that we were lagging behind the Americans, but I had not possessed any idea that they were so close to crossing the finish line of the Moon race.

“Really? The capitalists are that far ahead of us?”

“They are indeed. The Kremlin has been putting a great deal of pressure on me lately to deliver, and I have repeatedly had to tell Brezhnev and the rest of the Party leadership that the N-1 is almost ready for a manned Moon mission, it just needs a little more development. Surely, you understand why the next test flight with vehicle 5L will be crucial.”

“Yes. It shall be our only chance to produce a working lunar rocket in time.”

“Exactly. Keep that sense of urgency in mind, because I expect you to identify all of the problems in the first stage and correct them by the time we launch the next N-1 in July.”

“I’ll do my best, Chief Designer, but I fear that July will be far too soon for me to do what you ask.”

Mishin stood up from his seat and glared at me with the look of a stern schoolteacher.

“I simply cannot afford to tolerate any more delays at this point, Kuznetsov. Our space program is up against a wall here, and we can either triumphantly conquer space or sit here on Earth while the swine Americans make our Motherland look like a technological backwater. Now, I expect great results. Can I count on you?”

“You can.”

“Great. I suggest that you get to work on it.”

Mishin dismissed me, and I started walking down the corridors of the Cosmodrome administration building towards my office. At first, I panicked; I had just four months in which to carry out a design overhaul of the N-1’s first stage and ensure that it would not fail on its second flight, and if even the slightest malfunction occurred the entire vehicle could explode into flames. I would then have Mishin railing at me, and rightly so, for the United States would have been handed an unopposed lunar landing.

Things looked a little brighter, or at least less overwhelming, when I reminded myself why Korolev placed me in a senior position on the N-1 design team. It was because he had trained me personally in the techniques of aerospace engineering, and thought that said training made me qualified to handle design challenges just like the one that I presently faced. If I had to work sixteen or more hours a day, seven days a week to ensure a successful launch, then so be it. I would be doing a great service both to the Motherland and to the memory of Korolev, for the N-1 was his brainchild and his last great project. I could not fail him now.

I started to ponder ways to solve the KORD problem after being emboldened by that line of thought. Once I arrived in the fairly spartan and nondescript room that served as my office, I sat down at my desk, opened a drawer, extracted some blank papers and spare N-1 diagrams, and started frantically scrawling down notes. Compounding the difficulty of my task was the fact that N1-5L was already manufactured and being assembled in the Cosmodrome, meaning that any changes I made had to be minor enough for a pre-existing rocket to accommodate them.

By next morning, I thought that I had developed a preliminary solution. I quickly called together some of the men of my engineering team, such as Boris Chertok, Alexei Konstantin, and Ivan Petrov, in order to discuss it.

“Comrades, I just spent the whole of last night working on the design for the Block-A, and I have what amounts to at least a partial solution. As you explained during your debriefing, Boris, the KORD’s issuance of an erroneous command was caused by excessive heating and vibration in its location at the back of the first stage. We can’t make any meaningful modifications to the engines, at this point, but I think we can move the KORD,” I said.

“Where do you suggest putting it? It has to be somewhere near the engines, as otherwise managing all of its control cables would quickly become untenable,” Chertok said.

“I was thinking the upper transition section. We’ll have plenty of space between the two spherical oxidizer and kerosene tanks, not to mention that it would be fairly easy to access.”

“The problem is, that solution addresses a symptom of the overheating of the aft stage, but does not solve it. The engines will still create excess heat, and they might cause other sensitive components to catch fire,” Konstantin said.

“Good observation, Alexei. Perhaps we could install a heat shield of some sort, to protect the bottom of the Block-A,” Petrov stated.

“Yes, yes. An ablative plastic heat shield would be quite effective at carrying away much of the thermal energy of the engines. Perhaps we could provide some additional cooling by opening up the fuel line covers so as to ventilate the rocket,” I said as I picked up a pencil again and enthusiastically started to outline some of the modifications. My team and I were figuring this out; maybe, just maybe, things would come together after all.

**3 July 1969:**

My initial optimism turned out to be somewhat misplaced. Moving the KORD system took all of two months, since my team had to dismantle most of the first stage of N1-5L in order to get at it in the first place, and once that was done we had to contend with the veritable Gordian knot of control wires that had to be taken apart and relocated as well. There was also the issue that procuring the parts for the heat shield, simple and crude an apparatus as it was, took far longer than it should have due to the abysmal state of the Soviet Union’s aerospace supply chain and the negligence of its various manufacturers. The only modification that went according to plan was the rather trivial removal of the aft panels on the first-stage fuel line covers.

During the hectic four months between the beginning of March and the beginning of July, I largely eschewed food, sleep, and exercise so as to satisfy the immense time requirements of the N-1 program, and when I was not in my office making technical diagrams and doing calculations I was overseeing the implementation of my modifications in Site 112, the Cosmodrome’s cavernous assembly hall. My usually poor health started to decline even further as a result. As a child growing up in the Great Patriotic War against Nazi Germany, I had nearly starved to death during the siege of Leningrad, and the lingering effects of that became increasingly apparent as I pushed myself to the limit, both physically and mentally.

At last, the day of the second launch arrived. N1-5L had been rolled out to the pad some weeks before, with a number of untested alterations that would hopefully improve performance over the catastrophically failed N1-3L, and just as before I entered the control bunker with several other eminent personnel in order to get a close but protected look at the test flight.

The countdown continued for some time until Commander of the Sixth Directorate Yevegney Moisseyev pressed the button to activate the first stage. I watched the first jets of exhaust start to flow forth from the Block-A’s NK-15s.

Soon afterwards, N1-5L’s engines were now providing their full 4,590 tons of thrust, and the mammoth of a rocket started to slowly ascend into the night sky. I almost had to avert my eyes from the brightness of the exhaust plume.

“Five seconds: flight normal,” the flight announcement reported.

“Ten seconds: flight normal.”

“Let’s hope this works,” I muttered nervously, my palms drenched in perspiration.

Almost as soon as I had said that, the engines cut out and the rocket halted its ascent, staying stationary in the air for just a second before plummeting downwards into its own cloud of exhaust. I could only watch in horror as N1-5L slammed violently into the launchpad that it had occupied mere seconds before. The entirety of it, from the first stage upwards, became rapidly submerged in an expanding conflagration of burning kerosene and oxidiser, and only the unmanned LOK capsule was able to survive with the aid of the launch escape rocket that lifted it away from the explosion.

I have been a staunch atheist all of my life, but at that moment, as I stood there in the launch control bunker, I could have sworn that I was looking straight into the fiery inferno of Hell itself. Thousands of tons of propellant are dangerous enough when they are combusted within rocket chambers designed specifically to handle controlled explosions. In the case of an uncontrolled explosion, such as one that I was presently witnessing, the results quickly go from merely “dangerous” to “apocalyptic”. As the oncoming shockwave knocked me to the concrete floor of the command post, it certainly felt like the world was coming to a spectacular end.

**21 July 1969:**

One perk of being back at the OKB-1 headquarters in Podlipki was the fact that, compared to Baikonur, the weather was fairly clement. There were few others. After the N1-5L fiasco, which destroyed both N-1 launchpads, Mishin had been absolutely livid, and he stuck to his promise of holding me personally responsible for the failure of the first stage. He only kept me on-site at the Cosmodrome long enough for my engineering team to find out that the cause had been something so inconsequential as a loose bolt lodged in a fuel pump, and, once that was done, I was stripped of my position as lead designer and demoted to an entry-level position on a civilian satellite project.

It was easy enough, if rather tedious, but several months of chronic overwork and stress down in Kazakhstan had drained me to the point where I was barely able to perform at the office. To compound my feelings of exhaustion and disappointment was the fact that, during my absence, my wife had filed for and been granted a divorce due to the long, frequent, and top-secret trips required by my profession; not only had my life’s work, and that of my mentor Korolev, literally gone up in flames before my eyes, the woman I loved had decided to leave me behind as well. The worst part was that I only had myself to blame for everything.

I was working through some calculations with a slide rule when one of my coworkers, Anton Vostrikov, walked up to my desk and planted a copy of the newspaper *Pravda* on it.

“What’s this?” I asked.

“Read it,” Vostrikov replied.

“Brezhnev Honors Steel Laborers,” I said, reading the first headline to catch my eye.

“Not that section. Look here,” Vostrikov said, pointing to one of the less conspicuous articles near the bottom of the page.

As I turned my eyes to take a look at it, I was greeted by a small, grainy picture of a man in a spacesuit standing in front of a spider-shaped spacecraft of some sort. Above it ran the headline “American Cosmonauts Land on Moon in Historic Apollo 11 Flight.”

“The capitalist pigs managed to beat us in the race after all,” I said. I had known that this was coming for a while, but that didn’t make complete, utter failure sting any less.

“Yeah. Worst part is, some politicians at the Kremlin are starting to tell the world that we never even competed to begin with. I know full well that some of the engineers at this bureau were building a rocket to get there first. Was that where you worked before transferring to this department, by any chance?”

“I can’t say I know what you’re talking about, comrade.”

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* Russian names comprise a given name, a patronymic, and a surname.

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* In the Soviet Union, press coverage of the Apollo 11 Moon landing was scarce, but present. *Pravda* had a small article on the first page about it.
* Many Soviet engineers resented the fact that they were beaten to the Moon, while others attempted to ignore it.

3. Furniss, Tim. *The History of Space Vehicles*. San Diego: Thunder Bay, 2001. Print.

* American astronauts Neil Armstrong and Edwin Aldrin landed safely in the Moon’s Sea of Tranquility on July 20, 1969.
* In the N-1’s second test flight, on 3 July 1969, a stray metal fragment disabled an engine that took others with it, causing a catastrophic launch failure that took out both that rocket’s pad and an adjacent one.

4. Gerovitch, Slava. “Stalin’s Rocket Designers’ Leap into Space: The Technical

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* The Soviet system of contractors and subcontractors for the aerospace industry was absolutely abysmal.
* The military space program was very closely intertwined with the civilian space program.
* The Lead Designer was the man in charge of a particular subsystem, who was appointed by the Chief Designer and reported directly back to him.
* The Soviet engineering community was very close-knit and homogeneous. Also, engineers often had to put up with long stays away from home.
* Korolev was the leading rocket scientist in the early days of the Soviet space program, and was responsible for Sputnik, Vostok, and many of its other successes.

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* The OKB-1 design bureau was based in the city of Podlipki, now renamed to Korolev.

6. Johnson, Matt. *N-1: For the Moon and Mars, a Reference Guide to the Soviet*

*Superbooster*. Livermore: ARA Press, 2013. Print.

* Sergei Korolev died in 1966 from surgical complications exacerbated by chronic overwork, and thus did not see the completion of his brainchild N-1 rocket.
* The LOK spacecraft would have been the main manned vessel of the N-1 program. It was, in essence, a modified two-man version of the Soyuz.
* The Block-A first stage of the N-1 had thirty NK-15 engines, with 24 on the outside ring and six in a central ring group. Pitch and yaw were controlled by the careful variation of each engine’s thrust level.
* A system known as the KORD was used to control all engines simultaneously.
* The first and second rockets bore the designations N1-3L and N1-5L, respectively.
* The first N-1 was grey, save for a white stripe on the third stage, and the second one was all white.
* The N-1 rocket had three stages for the launch vehicle proper, namely the Block-A, Block-B, and Block-V, which would have put the L3 Complex into orbit around the Earth. Then, the first L3 stage, the Block-G, would fire to send the ship to the moon, and the Block-D would brake it into lunar orbit and take the LK lander down to the surface. The Soviets would then have used the LK engine to get back into orbit and the LOK engine to return to Earth.
* In 1964, most of OKB-1’s resources were turned towards a manned lunar expedition to beat the Americans.
* Korolev was greatly missed after his passing, and many thought that, had he survived, the space program would have been far better off for it.
* Mishin was a competent engineer and manager who succeeded Korolev as Chief Designer of OKB-1.
* The first N-1 flight test went haywire 55 seconds after launch due to the failure of an engine on the first stage. This caused the automatic flight control system to jettison the mock payload and shut down all of the engines, though the latter action was unable to prevent the explosion of the rocket.
* The second N-1 flight test set the Soviets back in the Space Race.
* The explosion of N1-5L was so large that it remains one of the largest non-nuclear man-made explosions in history.
* To fix heating problems, engineers installed an ablative plastic shield on the underside of the first stage.
* Also, the Block-A fuel line covers were opened for additional cooling through increased ventilation.
* The KORD system was moved to the top of the first stage after the N1-3L test.

7. Kubilius, Kerry. “Russian Patronymics.” *About.com*. N.p., 2015. Web. 17 Feb. 2015.

<<http://goeasteurope.about.com/od/russianculture/a/russianpatronymics.htm>>.

* In Russian culture, coworkers traditionally refer to each other by first name and patronymic.

8. “Moon Phases February 1969.” *Calendar-12.com*. N.p., 2015. Web. 19 Feb. 2015.

<<http://www.calendar-12.com/moon_calendar/1969/february>>.

* On February 20th, 1969, the moon was a waxing crescent.

9. “N1.” *Encyclopedia Astronautica*. N.p., n.d. Web. 9 Feb. 2015.

<<http://www.astronautix.com/lvs/n1.htm>>.

* Soviet authorities denied that the N-1 had ever existed.

10. “The 1960s: Science and Technology: Overview.” American Decades. Ed. Judith S.

Baughman, et al. Vol. 7: 1960-1969. Detroit: Gale, 2001. Student Resources in Context. Web. 30 Jan. 2015.

* The Space Race was a technological struggle between America and the Soviet Union, in which each side attempted to outdo the other in technical accomplishments in space.

12. “Pravda.” *Encyclopaedia Britannica*. Encyclopaedia Britannica, Inc., 29 May 2014. Web.

28 Feb. 2015. <<http://www.britannica.com/EBchecked/topic/474092/Pravda>>.

* *Pravda* was the official newspaper of the Soviet government.

13. RKK Energia. “N1 5L Night Launch.” *Encyclopedia Astronautica*. N.p., n.d. Web. 9 Feb.

2015. <http://www.astronautix.com/lvs/n1.htm>.

* The N-1 had the appearance of a skyscraper-sized truncated cone, painted white with two large breaks in the surface that comprised the interstage fairings. A launch escape tower was positioned at the top.

14. “The Siege of Leningrad, 1941 - 1944.” *EyeWitness to History.com*. Ibis

Communications, n.d. Web. 1 Mar. 2015.

<http://www.eyewitnesstohistory.com/leningrad.htm>.

* In World War II, the German Army encircled and besieged the city of Leningrad. Mass starvation within the city ensued until it was relieved in 1944.

15. “Soviet Cars.” *History of Russia*. N.p., 2015. Web. 13 Feb. 2015.

<http://historyofrussia.org/soviet-cars/>.

* Lada, Volga, Zil, and Mosckvich were popular brands of Soviet cars.

16. Zak, Anatoly. “History of Energia-Buran facilities in Baikonur.” *RussianSpaceWeb.com*.

N.p., 21 Feb. 2014. Web. 9 Feb. 2015.

<<http://www.russianspaceweb.com/baikonur_energia_history.html>>.

* The N-1 launch complex consisted of two colossal launch pads, tall service towers, flame pits, a command post, and an administrative building.

17. - - -. “Lunar Module (LK).” Ed. Alain Chabot. *RussianSpaceWeb.com*. N.p., 22 Nov.

2014. Web. 9 Feb. 2015. <http://www.russianspaceweb.com/lk.html>.

* The LK lunar lander, to be launched aboard the N-1, was essentially a crew cabin attached to a rocket motor that was in turn suspended within a four-legged landing frame.

18. - - -. “N1 Moon Rocket.” *RussianSpaceWeb.com*. N.p., 3 July 2014. Web. 9 Feb. 2015.

<http://www.russianspaceweb.com/n1.html>.

* The N-1 Block-A stage had over 4,590 tons of thrust provided by 30 engines at liftoff, and it was 30.09 meters tall and 16.875 meters wide.
* The N-1 itself was over 105 meters tall, with a diameter of 17 meters and a liftoff mass of 2,783-2,825 tons (only 281 tons without propellant). It could push 95 tons of payload into orbit around the Earth.

19. - - -. “N1 No. 3L launch.” Ed. Alain Chabot. *RussianSpaceWeb.com*. N.p., 9 Sept. 2014.

Web. 23 Feb. 2015. <http://www.russianspaceweb.com/n1\_3l.html>.

* After the engines all spontaneously cut off, N1-3L continued upwards for a moment before plummeting into the ground.
* The payload for this launch was a stripped-down L3 complex with only the L1 spacecraft, a version of the LOK.
* Nobody knew that the KORD system was to blame for the failure, at least at first. They did know that the LES activated, engines 12 and 24 had shut down early on, and at T +68.7 seconds all engines were shut down. Mishin immediately blamed Andronnik Iosifyan's power system for the problem.
* After the failure, Boris Chertok’s KORD system was placed under scrutiny.
* He presented his findings at a conference on March 7.
* People in the N-1 fire control bunker included Yevgeny Moisseyev, Anatoly Kirillov, Deputy Chief Designer Boris Dorofeev, and Vasily Mishin. There was also Minister Sergei Afanasiev. The rocket was activated for the first time at 12:17 (Moscow Time), and it lifted off.
* From telemetry and physical analysis of recovered rocket parts, it was found that the power generators did not cause the failure of the 3L launch.
* Most N-1 project leaders were still fairly confident after the failure of the 3L launch, since it had demonstrated that most systems worked and collected a great amount of data. Note: this is the main aspect in which my story differs from actual history; I had to downplay the positive attitude of N-1 project engineers following N1-3L so as to create more of a conflict.

20. - - -. “Site 112.” *RussianSpaceWeb*. N.p., 7 Apr. 2014. Web. 23 Feb. 2015.

<<http://www.russianspaceweb.com/baikonur_energia_112.html>>.

* N-1 rocket stages were assembled together at Site 112, located within Baikonur Cosmodrome

21. - - -. “Vasili Mishin.” *RussianSpaceWeb.com*. N.p., n.d. Web. 25 Feb. 2015.

<http://www.russianspaceweb.com/mishin.html>.

* Vasily Mishin's middle name was Pavlovich. This seems extremely minor, but I needed his patronymic for parts of the dialogue and could not find it anywhere else, so I went ahead and made an entire source card for that one minor little detail.